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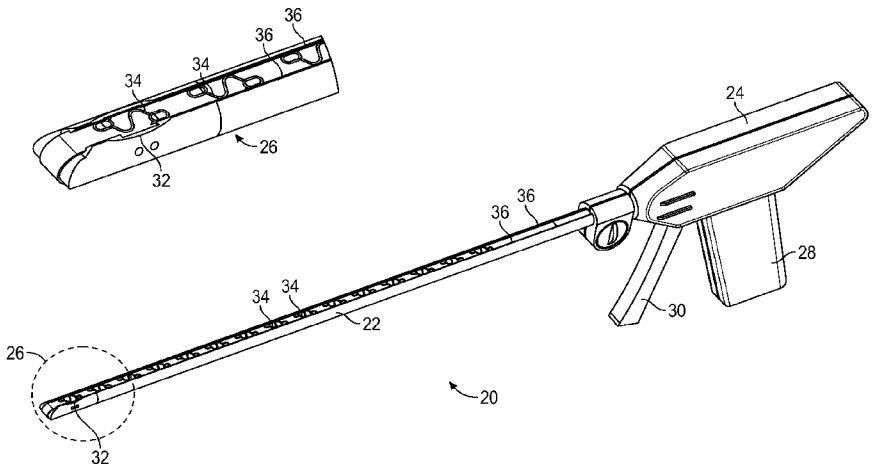


FIG. 1

(57) Abstract: A medical fastening device is provided. The fastening device may include a first arcuate needle adapted to rotate about a first axis in a first direction, entering through a first section of one of a tissue and a prosthetic material, and exiting through a second section of one of the tissue and the prosthetic material; a second arcuate needle adapted to rotate about a second axis in a second direction, entering through the second section of one of the tissue and the prosthetic material, and exiting through the first section of one of the tissue and the prosthetic material; and a drive mechanism operatively coupled to each of the first and second arcuate needles and configured to engage each of the first and second arcuate needles between a retracted position and an extended position.

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AMENDED CLAIMS
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What is claimed is:

1. A fastening device, comprising:

a first arcuate needle adapted to rotate about a first axis in a first direction, entering through a first section of one of a tissue and a prosthetic material, and exiting through a second section of one of the tissue and the prosthetic material;

a second arcuate needle adapted to rotate about a second axis in a second direction, entering through the second section of one of the tissue and the prosthetic material, and exiting through the first section of one of the tissue and the prosthetic material; and

a drive mechanism operatively coupled to each of the first and second arcuate needles and configured to engage each of the first and second arcuate needles between a retracted position and an extended position, the drive mechanism being configured such that each of the first arcuate needle and the second arcuate needle maintains a low-profile in the retracted position.

2. The fastening device of claim 1, wherein the first axis is axially offset from the second axis.

3. The fastening device of claim 1, wherein the first axis is coaxial with the second axis.

4. The fastening device of claim 1, wherein the first direction is the same as the second direction.

AMENDED SHEET (ARTICLE 19)

5. The fastening device of claim 1, wherein the first direction is opposite of the second direction.

6. The fastening device of claim 5, further comprising at least one additional arcuate needle configured to rotate about a third axis in a third direction, the third axis being coaxial with at least one of the first and second axes, and the third direction being the same as at least one of the first and second directions.

7. The fastening device of claim 1, wherein each of the first and second arcuate needles provides a recess configured to engagably receive an end of a fastener therein.

8. The fastening device of claim 1, wherein the first and second arcuate needles rotate at identical and symmetrical rates of angular displacement.

9. The fastening device of claim 1, wherein the first and second arcuate needles rotate at non-symmetrical rates of angular displacement.

10. The fastening device of claim 1, wherein the first and second arcuate needles rotate sequentially relative to one another.

11. The fastening device of claim 1, wherein the drive mechanism is configured such that each of the first and second arcuate needles pulls one end of a fastener to be installed

through the first and second sections of one of the tissue and the prosthetic material as the first and second arcuate needles are retracted in a retrograde configuration.

12. The fastening device of claim 1, wherein the drive mechanism is configured to, upon actuation, advance each of the first and second arcuate needles in a forward rotation through one of the tissue and the prosthetic material to engage ends of a fastener to be installed; and upon release, retract each of the first and second arcuate needles in a reverse rotation through one of the tissue and the prosthetic material to pull the engaged ends of the fastener into a helical configuration.

13. The fastening device of claim 1, wherein the drive mechanism is configured such that each of the first and second arcuate needles pulls one end of a fastener to be installed through the first and second sections of one of the tissue and the prosthetic material as the first and second arcuate needles are advanced in an antegrade configuration.

14. A tissue fastening device, comprising:

an elongate member extending between a working end and a control end having at least one guide for receiving one or more fasteners, the working end having a firing aperture in communication with the at least one guide;

a first arcuate needle disposed within the firing aperture of the working end and adapted to rotate about a first axis in a first direction, entering through a first section of one of a tissue and a prosthetic material, and exiting through a second section of one of the tissue and the prosthetic material;

a second arcuate needle disposed within the firing aperture of the working end and adapted to rotate about a second axis in a second direction, entering through the second section of one of the tissue and the prosthetic material, and exiting through the first section of one of the tissue and the prosthetic material; and

a drive mechanism operatively coupled to each of the first and second arcuate needles and configured to engage each of the first and second arcuate needles between a retracted position and an extended position in response to user input received through the control end.

15. The tissue fastening device of claim 14, wherein the drive mechanism is manually actuated by use of a trigger disposed at the control end of the elongate member, the trigger being movable between an engaged position and a disengaged position, the engaged trigger position corresponding to the extended needle position and the disengaged trigger position corresponding to the retracted needle position.

16. The tissue fastening device of claim 14, further comprising a ribbon cartridge holding a ribbon of a plurality of fasteners linearly disposed therealong, the ribbon cartridge being configured to hold at least one fastener over the firing aperture of the working end prior to installation so as to be engageable by the first and second arcuate needles upon release.

17. The tissue fastening device of claim 16, wherein the ribbon is advanced after each installation to hold a subsequent fastener over the firing aperture.

18. The tissue fastening device of claim 14, wherein one or more of the working end and the elongate member is rotatable relative to the control end and about a common longitudinal axis thereof.

19. The tissue fastening device of claim 14, wherein the working end is movable relative to the elongate member.

20. The tissue fastening device of claim 14, wherein each of the first and second arcuate needles provides a recess configured to engagably receive an end of a fastener therein.

21. The tissue fastening device of claim 14, wherein the drive mechanism is configured such that each of the first and second arcuate needles pulls one end of a fastener through the first and second sections of one of the tissue and the prosthetic material as the first and second arcuate needles are retracted in a retrograde configuration.

22. The tissue fastening device of claim 14, wherein the drive mechanism is configured to, upon actuation, advance each of the first and second arcuate needles in a forward rotation through one of the tissue and the prosthetic material to engage ends of a fastener to be installed; and upon release, retract each of the first and second arcuate needles in a reverse rotation through one of the tissue and the prosthetic material to pull the engaged ends of the fastener into a helical configuration.

AMENDED SHEET (ARTICLE 19)

23. The tissue fastening device of claim 14, wherein the drive mechanism is configured such that each of the first and second arcuate needles pulls one end of a fastener through the first and second sections of one of the tissue and the prosthetic material as the first and second arcuate needles are advanced in an antegrade configuration.

24. The tissue fastening device of claim 14, wherein the first axis is axially offset from the second axis.

25. The tissue fastening device of claim 14, wherein the first axis is coaxial with the second axis.

26. The tissue fastening device of claim 14, wherein the first direction is the same as the second direction.

27. The tissue fastening device of claim 14, wherein the first direction is opposite of the second direction.

28. The tissue fastening device of claim 27, further comprising at least one additional arcuate needle configured to rotate about a third axis in a third direction, the third axis being coaxial with at least one of the first and second axes, and the third direction being the same as at least one of the first and second directions.

29. The tissue fastening device of claim 14, wherein the first and second arcuate needles rotate at identical and symmetrical rates of angular displacement.

30. The tissue fastening device of claim 14, wherein the first and second arcuate needles rotate at non-symmetrical rates of angular displacement.

31. The tissue fastening device of claim 14, wherein the first and second arcuate needles rotate sequentially relative to one another.

32. The tissue fastening device of claim 14, wherein the firing aperture is configured as one of a side-firing aperture, an end-firing aperture, and an oblique-firing aperture, relative to the working end.

33. A tissue fastening device, comprising:

an elongate member extending between a working end and a control end having at least one guide for receiving one or more fasteners, the working end having a firing aperture in communication with the at least one guide;

an arcuate needle disposed within the firing aperture of the working end and rotatable between a retracted position and an extended position, the arcuate needle including a recess configured to engagably receive an end of a fastener therein; and

a drive mechanism operatively coupled to the arcuate needle and configured to, upon actuation, advance the arcuate needle in a forward rotation through one of a tissue and a prosthetic material and engage an end of a fastener to be installed, and upon release, retract

the arcuate needle in a reverse rotation through one of the tissue and the prosthetic material to pull the engaged end of the fastener therethrough.

34. The tissue fastening device of claim 33, wherein the drive mechanism is manually actuated by use of a trigger disposed at the control end of the elongate member, the trigger being movable between an engaged position and a disengaged position, the engaged trigger position corresponding to the extended needle position and the disengaged trigger position corresponding to the retracted needle position.

35. The tissue fastening device of claim 33, further comprising a ribbon cartridge holding a ribbon of a plurality of fasteners linearly disposed therealong, the ribbon cartridge being configured to hold at least one fastener over the firing aperture of the working end prior to installation so as to be engageable by the first and second arcuate needles upon release.

36. The tissue fastening device of claim 33, further comprising a second arcuate needle disposed within the firing aperture and rotatable between a retracted position and an extended position, the second arcuate needle being coaxially disposed relative to the first arcuate needle and including a recess configured to engagably receive a second end of a fastener therein.

37. The tissue fastening device of claim 36, wherein the drive mechanism is operatively coupled to each of the first and second arcuate needles and configured to, upon actuation, simultaneously advance each of the first and second arcuate needles in a forward

rotation through one of the tissue and the prosthetic material and engage respective ends of a fastener to be installed, and upon release, simultaneously retract each of the first and second arcuate needles in a reverse rotation through one of the tissue and the prosthetic material to pull the engaged ends of the fastener therethrough.

38. The tissue fastening device of claim 36, further comprising at least one additional arcuate needle disposed between the first and second arcuate needles and configured to rotate in opposition to each of the first and second arcuate needles.

39. A tissue fastener, comprising:

an elongated filament having a leading end and a trailing end;

a needle guide disposed on the leading end; and

a retention member disposed on the trailing end, the retention member being configured to resist advancement through at least one of a tissue and a prosthetic material.

40. The tissue fastener of claim 39, wherein the needle guide is shaped into one of a loop, a circle, an ellipse, an oval, and a polygon, and configured to be engaged by a needle during deployment, the needle guide being configured to facilitate advancement of the needle guide through at least one of the tissue and the prosthetic material while resisting retraction thereof.

41. The tissue fastener of claim 39, wherein the needle guide of the leading end includes at least one retention element tangentially extending therefrom, the retention element

being configured to resist retraction through at least one of the tissue and the prosthetic material.

42. The tissue fastener of claim 39, wherein the leading end includes at least one retention element having one or more of a tine, a fin, and a canted element, the retention element being configured to resist retraction thereof.

43. The tissue fastener of claim 39, wherein the elongated filament includes one or more of linear and nonlinear segments.

44. The tissue fastener of claim 39, wherein the retention member includes at least one outwardly extending element that lies within a plane which at least partially intersects with a plane of the needle guide.

45. The tissue fastener of claim 39, wherein the retention member of the trailing end includes an open loop configured to receive the needle guide of the leading end therethrough and interlock therewith upon installation.